

Variations of Mental Fatigue on Inspectors in Automobile Industry During Evening Shift-A Case study of Maruti Suzuki India Limited, Gurgaon

Rahul Singal

Associate Professor , Prannath Parnami Institute Of Professional Studies, Hisar

Abstract-Product Quality inspection is an important task in the production of vehicles. Inspection occurs at many points in a process. Inspectors perform inspection of the finished product for many hours at a stretch. After continually monitoring the performance of inspectors, it was found that the mental alertness of inspectors and the number of defects caught by them in vehicles varies with time of day and their working shift, and inspectors varied in their abilities due to mental fatigue and tiredness. Fatigue impairs both physical and mental performance in humans. Mental fatigue is a psycho-biological state caused by prolonged periods of demanding cognitive activity and characterized by subjective feelings of “tiredness” and “inability to concentrate”. This research aims at determining the variations of mental fatigue on the Inspectors during inspection of vehicles at Maruti Suzuki India Ltd. In this study we have surveyed a sample of individuals working as inspectors in the industry. We have analysed the data according to the various factors that led to mental fatigue. A variety of data collection tools were used to assist in the data collection. The data collection tools used included personal interview, a mobile application-Alertometer. The result showed that, after different intervals the alertness level of inspectors goes down and their mind gets saturated due to mental fatigue as measured by the alertometer scores and personal interview.

Keywords-Mental Fatigue, Inspection, Reaction Time, Alertometer

I. INTRODUCTION

Vehicle inspection is the overall checking of vehicles (exteriors and interiors) for functional and appearance non-conformities. Inspection of the vehicles is based upon functional and appearance aspects before delivering them to the actual customer. Inspection task is considered as repetitive. It causes eye strain, mental strain and Fatigue. Fatigue of workers is a complex phenomenon resulting from various factors in technically innovated modern industries, and it appears as a feeling of exhaustion, lowering of physiological functions, breakdown of autonomous nervous balance and decrease in work efficiency and productivity within the workplace.

Safety and productivity in the workplace are intimately related to worker's health. A workplace may have chemical, physical, biological, and/or psychosocial hazards that have the potential to impact physical and psychological well-being. A workplace in which these hazards are well controlled, with an active culture of health and a supportive work environment, can enhance worker health and well-being, both on and off the job. Healthier employees result in fewer health claims, better safety records, and greater productivity and better quality of production. Well-rested, alert employees are critical to safe and productive operations. Virtually everyone experiences some level of fatigue from time to time. However, excessive fatigue while working is an important condition in which the interrelationship of health, safety, productivity and quality can create a vicious or a virtuous cycle. In addition, specific factors in the organization of work have been shown to promote either alertness or fatigue. Because of the potential impact of fatigue on health, safety, and productivity, any organization in which individuals work extended hours or hours during which people typically sleep can benefit from addressing fatigue in the workplace such as the transportation, health care, and energy industries.

1.1 Difference between Fatigue and Sleepiness

When the term fatigue is used, many think of it as the same as sleepiness, but these are actually two different states. Sleepiness is the tendency to fall asleep, fatigue is the body's response to sleep loss or to prolonged physical or mental exertion. Fatigue may be reduced by sedentary activity or rest without sleeping, whereas subjective sleepiness and the propensity for sleep are often exacerbated by sedentary activity or rest. Sleep propensity can be accompanied by decreased alertness which then leads to decreased attention to detail, impaired judgement, and slowed response time. This can affect productivity, safety and overall health.

Fatigue Risk Factors

- Sleep Deprivation
- Circadian variability
- Time awake
- Health factors (sleep disorders, medications)
- Environmental Issues (light, noise)
- Workload

This study aims at determining the variation of mental fatigue in inspectors working in shifts at Vehicle Inspection Department. This study has focussed on other tasks in another industry like alertness level, saturation point of Inspectors. The results showed that after different intervals the alertness level of the inspectors goes down and their mind gets saturated due to mental fatigue as measured by the alertometer scores and interview.

II. REVIEW OF LITERATURE

Fatigue may be defined as a transition state between alertness & somnolence (Desmond & Hancock, 2001). Fatigue is defined as the subjectively experienced disinclination to continue performing the task at hand (Brown, 2003). Fatigue cannot be measured directly and is defined operationally in terms of observable symptoms (Belz et al., 2010). Fatigue is defined as a persistent and subjective sense of tiredness that interferes with usual functioning. (Schwartz, 1998).

2.1 PHYSICAL FATIGUE

Physical Fatigue is known as muscle weakness or lack of strength (Christian Nordqvist, 2004).

2.2 MENTAL FATIGUE

Mental fatigue is defined as not having energy to do anything (Aworemi et al., 2010). Mental Fatigue is a psychological state caused by prolonged periods of demanding cognitive activity and characterized by subjective feelings of "tiredness" and "lack of energy" (Samuele M. Marcora, 2008).

2.3 STUDIES ON MENTAL FATIGUE

Fatigue is a risk factor which involves the hazard of accident and which therefore requires proper risk assessment to identify and estimate the extent and nature of the risk (Guppy et al., 2003). Two major physiological factors that generate fatigue are sleep loss and circadian rhythm disruption (Biggs, 2009). Mental fatigue is a particular problem for professional drivers and its role in causes of crashes should not be underestimated (Aworemi, 2010). The amount of sleep prior to driving and deviation from the normal human circadian rhythm are clear contributors to mental fatigue (Jensen and Dahl, 2009). The main fatigue related issue is not enough sleep (Hanowski, 1999). Mental fatigue impairs physical performance in humans (Marcora SM, 2009). Proper work-rest period at the workplace reduces mental fatigue (Rungchat Chompu-inwai and Kanitha Yajom, 2010). Mental Fatigue affects Visual Selective Attention (Faber LG, Maurits NM, Lorist MM, 2012). Fatigue can adversely affect performance on subsequent tasks after a prolonged performance without rest (Orasanu & Backer, 2001). In industries, working in the morning shift resulted in a higher fatigue level than working in the night shift and the temperature of the work environment was the most important factor contributing to the higher fatigue level (J Hum Ergol, 1996). Mental Fatigue limits exercise tolerance in humans through higher perception of effort rather than cardiorespiratory and musculoenergetic mechanisms. (Walter Staiano, 2009). It is estimated that over 200,000 auto accidents per year are attributed in part to sleep disruption and fatigue. (Asken & Raham, 1971).

Small amounts of sleep such as 3 to 4 hours per night, can be quite beneficial in sustaining performance through several days (Orasanu & Backer, 1996). Some central and peripheral factors affect human motor output in neuromuscular fatigue (Gandevia SC, 1992). Muscular endurance and surface electromyogram is isometric and dynamic exercise (Hagberg M, 1981). The human adult requires approximately eight hours of sleep for optimal performance and alertness, some people however, require as little as six hours sleep and others as much as 10 hours (Grandjean, 1988). It was found that sleep loss can degrade potentially any (and every) aspect of human performance, including vigilance, decision making and reaction time (Neri, 1997). Fatigue can increase with task workload and the time spent engaged on a task (Matthews and Desmond, 2002). Fatigue has many effects on a driver (Charlton and Bass, 2001).

2.4 STUDIES ON STRESS MANAGEMENT

The individuals working in the information technology field face more stress because they have to update their knowledge continuously (Dr. B. Chandra Mohan Patnaik, 2004). Job Satisfaction is directly related to Stress and Work culture that an Organization provides (Singh A. P. & Singh S, 2009). - Higher stress is directly proportional to quality of work life for IT professionals (Charu M., 2013). The women face more stress than men in the organization to be more specific married women faces more stress than the unmarried women (Kavitha, 2012). Occupational Stress is as same as Job Stress that need to be controlled at the workplace (Satija S. & Khan W., 2013). Employee's performance at work is influenced by stress that can be either positive or negative (Karthik R., 2013). Stressors affect the efficiency of information processing generally by degrading performance (Driskell & Salas, 1996). The major causes of stress are firstly workload, secondly timings, thirdly climate (Bhatti N., 2010).

III. RESEARCH METHODOLOGY

3.1 PROBLEM STATEMENT

To identify the cause and effect of mental fatigue.

3.2 SAMPLE

It included a sample of all the inspectors working in Vehicle Inspection, Plant-1

3.3 SAMPLE SIZE

A sample of 12 inspectors were taken and interviewed.

3.4 TYPE OF DATA

This research used both type of data-Primary as well as Secondary data.

The primary data was collected by conducting personal interview and a mobile application i.e Alertometer®. The number of non-conformities identified by the inspectors per vehicle with respect to time, in both shifts was also studied to support the thesis.

3.5 DATA COLLECTION TOOLS

3.5.1 PERSONAL INTERVIEW

The personal interview consisted of some basic questions to record general information like name, work experience, preferred shift etc. It also included questions to understand from an inspectors point of view, the times at which their mind reached a saturation level. There were 5 questions as follows:

Name.....

Work Experience.....

Which shift is better (A/B)?.....

Satisfied by break provided?.....

When your mind gets saturated?.....

Each inspector was asked to answer the questions in both shifts.

3.5.2 ALERTOMETER®

- Alertometer® is a software application developed by Bowles-Langley Technology with assistance from NIH and NIOSH.
- It was developed to measure reaction time and other basic brain functions of human beings.
- This was app was specifically developed for the use of Safety Managers to test the general alertness of employees.
- We selected this app for measuring the alertness of first appearance inspectors at different times of the day.

Alertometer® Score: The app gives a score which takes into account the accuracy and the reaction time of the subject. A higher score translates to a quicker and a more accurate set of responses and a lower score vice versa.

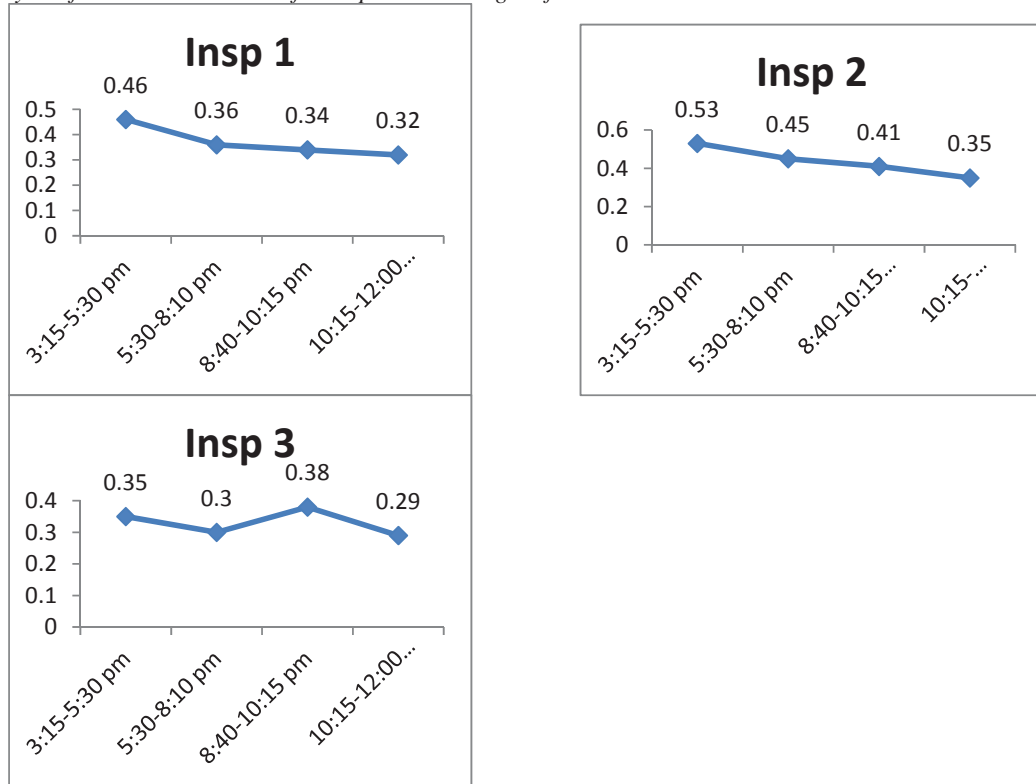
*Reaction Time-*It means the interval time between application of a stimulus and detection of a response. The higher the reaction time, the lower the mental fatigue.

OBJECTIVES OF THE STUDY

- To study the current system of analyzing mental fatigue.
- To identify the cause and effect of mental fatigue in **Evening Shift**.
- To implement feasible solutions to reduce the effect of mental fatigue after prolonged inspection activity.

IV. DATA ANALYSIS AND RESULTS

a. Analysis of Alertometer scores of Group A in Evening Shift.



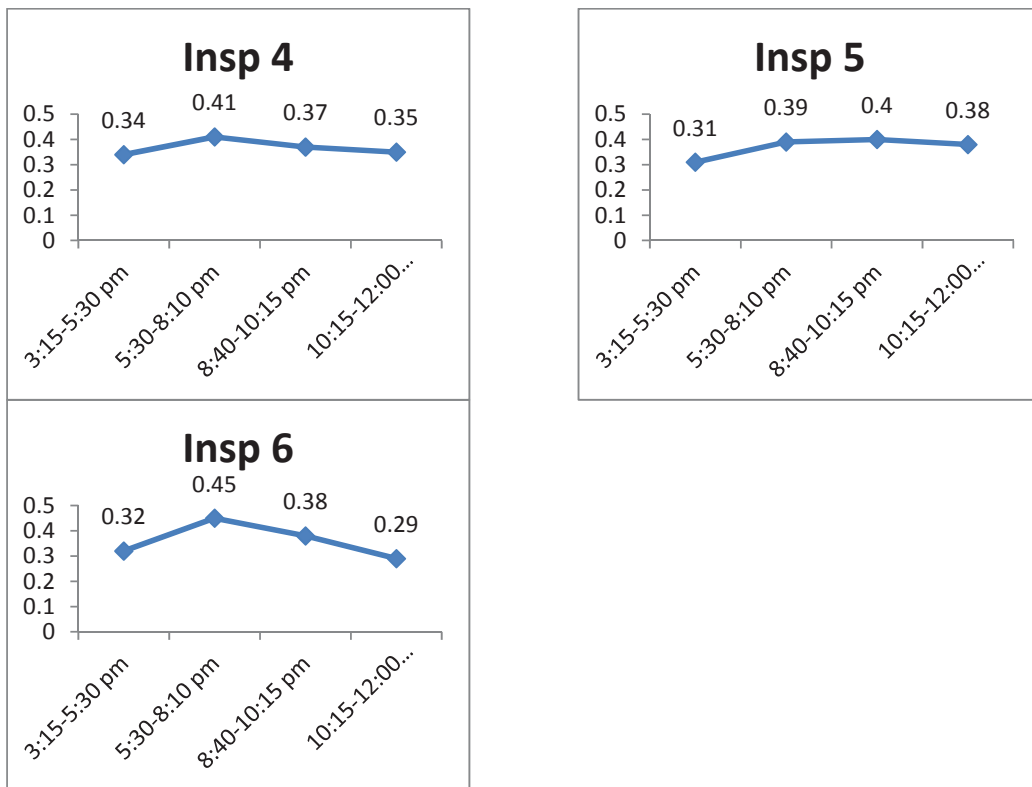
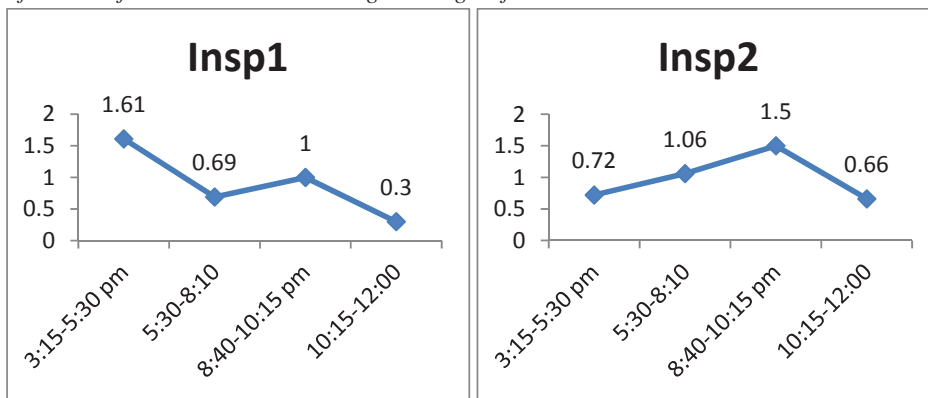


Fig-1 Analysis of Alertometer scores in Evening Shift

b. No. of Non-conformities observed during Evening shift



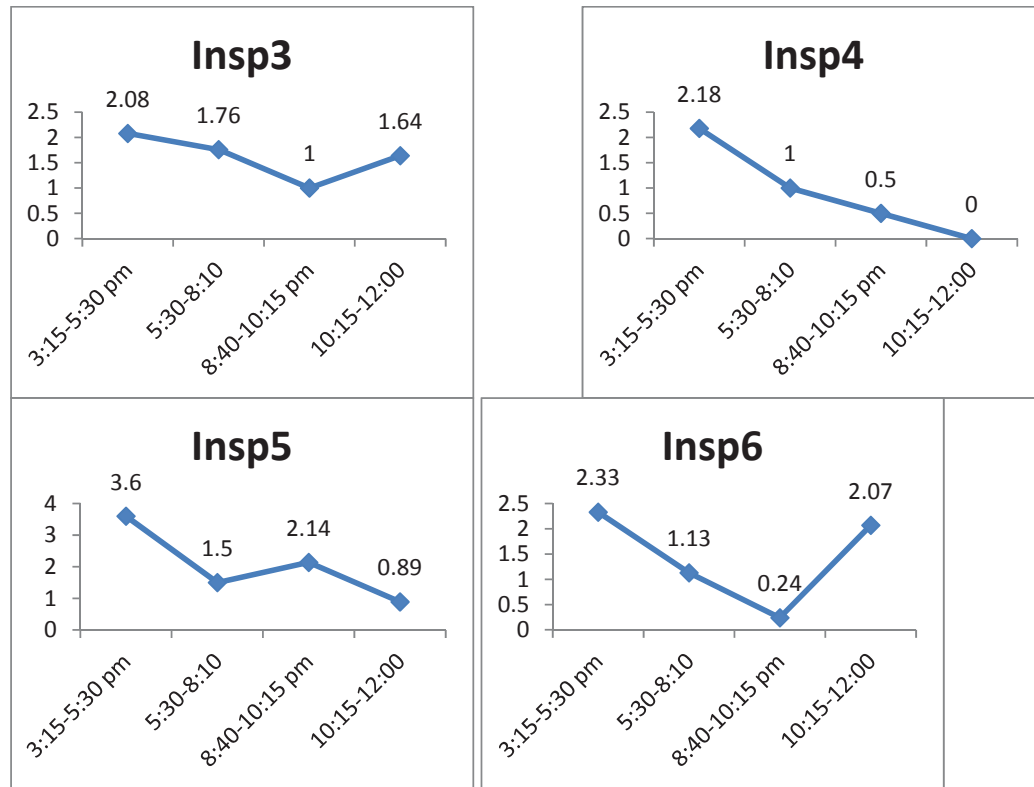


Fig 2-Non-conformities during Evening Shift

V. FINDINGS AND SUGGESTIONS

a. FINDINGS

- As inferred from the study there are different times of the day when the alertness levels are at their lowest.
- The results in evening shift show wide variations from inspector to inspector.
- The alertness level remains same for some whereas it increases little for some during the interval before dinner.
- After dinner finishes at 8:40 pm, wide variations in alertness can be seen for some inspectors but it can be said that alertness levels decrease slightly after dinner.
- After the second tea break at 10:15 pm, there is a decrease in the alertness level.
- We can see that the number of non-conformities/defects per vehicle shows a direct co-relation with the alertness levels in both the shifts.
- It can be observed directly that the number of defects observed per vehicle is higher when alertness levels are higher and corresponding number of defects observed by the inspectors were lower where the alertness levels were at the lowest.

6.2 SUGGESTIONS

- We have studied various options to mitigate the low alertness levels.
- A rotation of inspectors between different areas of inspection may be used to mitigate the low alertness level period during the second half of evening shift.

VI. CONCLUSION

- During the start of the shift, inspectors are at their base line alertness levels.

- As time progresses, alertness levels decrease, a direct conclusion of increased fatigue.
- In Evening shift, it can be observed that the alertness levels reach the lowest towards the end of the shift. This is due to the natural circadian rhythms of sleep and wakefulness.

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